Simultaneous Skin Friction and Pressure Sensitive Paint, Phase I

Completed Technology Project (2012 - 2012)

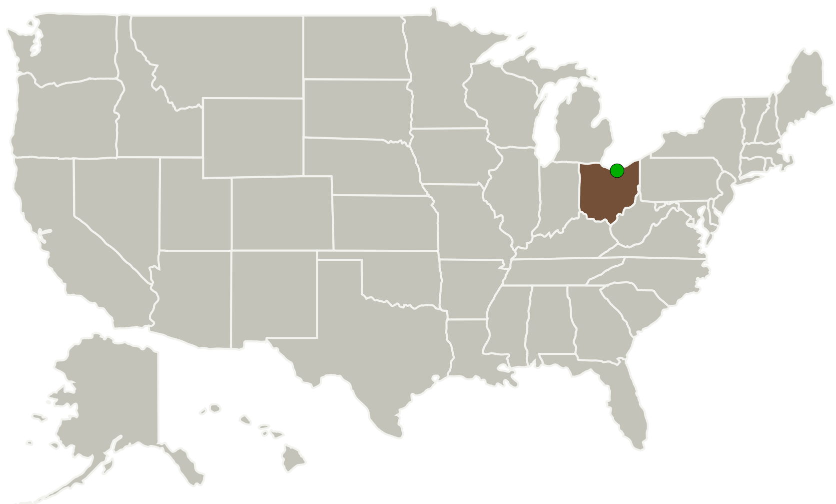
Project Introduction

Currently, the contribution of skin friction to the total drag of a wind tunnel model is estimated by comparing measurements of the total drag to the integrated pressure drag. While this yields an estimate for the average skin friction, the distribution of the skin friction cannot be determined from such measurements. The distribution of skin friction and pressure is available from computational fluids models, however, these models must be validated using experimental data. An experimental tool for distributed measurements of skin friction and pressure would be useful for both aerodynamic configuration development and numerical code validation. We propose the development of an image-based sensor for simultaneous measurements of skin friction and pressure that is based on combining Pressure-Sensitive Paint with a new image-based measurement technique for skin friction, Surface Stress Sensitive Films (S3F). The basis of the S3F technique is an elastic film that distorts under the action of the applied forces. Skin friction is determined by monitoring these distortions and applying a finite element model to the film. The S3F technique can operate over a range of temperatures from cryogenic (160 K) to well above ambient (470 K), thus there is a potential to deploy this system in a variety of wind tunnels. Quantitative measurements of skin friction using S3F have been demonstrated from 10-m/s to Mach 5 and the accuracy of the S3F sensor has been validated to be better than 5% full scale in a fully developed channel and high Reynolds number boundary layer. Several experimental demonstrations of a combined PSP/S3F sensor have been performed in small wind tunnels and bench-top experiments, thus demonstrating that this approach is possible. The key innovations in this proposal are to develop a multi-color data acquisition system that can acquire both pressure and skin friction data simultaneously, and validate the accuracy and stability of the combined sensor.

Simultaneous Skin Friction and Pressure Sensitive Paint, Phase I

Table of Contents

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Innovative Scientific Solutions, Inc.	Lead Organization	Industry	Dayton, Ohio
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations
Ohio

Project Transitions

February 2012: Project Start

August 2012: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/138687)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Innovative Scientific Solutions, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

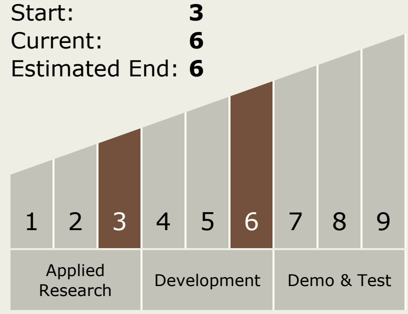
Carlos Torrez

Principal Investigator:

Jim Crafton

Technology Maturity (TRL)

Start: **3**
Current: **6**
Estimated End: **6**



Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  - └─ TX15.1 Aerosciences
    - └─ TX15.1.1 Aerodynamics

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System